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The Effectiveness of Gamebook Teaching-Learning Approach in Undergraduate MBBS Course in Comparison with the Conventional Teaching-Learning Approach

Khine Pwint Phyu¹, Thein Win Min¹, Lim Su Yin¹, Anitha Ponnupillai¹, Lim Yin Sear¹, Roland Gamini Sirisinghe¹, Ben Kumwenda²

¹*School of Medicine, Faculty of Health and Medical Sciences, Taylor's University, Selangor, MALAYSIA*

²*School of Medicine, University of Dundee, Scotland, UNITED KINGDOM*

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ABSTRACT

Among various methods of learning and teaching, educational games are tools that engage students for both educational purposes and entertainment. This study aimed to evaluate the effectiveness of game-based learning (GBL) for undergraduate obstetrics and gynecology students in the form of a gamebook. A quasi-experimental study was conducted to compare the outcomes of two different teaching methods, conventional case-based learning (CBL) and GBL, on undergraduate medical students from Taylor's University, Malaysia. A statistical analysis was performed to compare the performance between the control and intervention groups. Single-best-answer multiple-choice questions (MCQs) were used to assess students' knowledge and understanding of the clinical subject content, and a 5-point Likert scale was used to assess students' perception of the new teaching method. Chi-squared tests were used to compare the mean academic performance of the two groups of 128 participants. There was no significant difference in the post-intervention MCQ scores. Students in the GBL group found that learning is more enjoyable and felt more confident in managing patients both theoretically and in real world situations. In conclusion, GBL is comparable to conventional CBL in achieving the desired knowledge and understanding of the topics with a more positive perception towards GBL.

Keywords: *Game-based learning, Medical student, Obstetrics and gynecology, Undergraduate MBBS, Conventional teaching-learning*

CORRESPONDING AUTHOR

Khine Pwint Phyu, School of Medicine, Faculty of Health and Medical Sciences, Taylor's University, 1 Jalan Taylors, 47500 Subang Jaya, Selangor, Malaysia

Email: pwintphyu.khine@taylors.edu.my

INTRODUCTION

Education can be understood as two articulating processes, teaching and learning (1). The goal of teaching is to ensure that the learners learn what they intended to learn, and the duty of an educator is to ensure the students have met their learning objectives. Nowadays, the digital revolution of the recent decade is increasing pressure on traditional teaching pedagogies and the younger generation prefers alternative and innovative learning techniques. Hermes et al. (2) acknowledged that digital technologies are transforming medical educational institutions. Some educators consider that game-based learning (GBL) and case-based learning (CBL) are similar pedagogies (3). Gros (4) voiced that engagement and motivation are interesting benefits of the use of digital games in training to improve various skills.

GBL is the integration of game-like activities in teaching and learning to increase student engagement and motivation. It is also known as “gamification,” “educational games,” and “serious games” (5–7). The gaming concepts of competition, recreation, setting goals, rewards, and feedback are applied in educational games (8). Some robust evidence suggested that games can motivate learning and help to understand complex subject matter (9, 10).

Several authors commented that serious gaming in medical education continues to grow and establish itself (11–13). However, very few studies have expounded the usefulness of GBL specifically for the teaching of obstetrics and gynecology (O&G) (14–16). Silverio and Chen (14) conducted a recent study on GBL in obstetrics emergency deliveries with a focus on the evaluation and management of obstetrics emergency labour. However, the limitation of their study was the lack of alternative conventional learning methods that could have been used to assess and compare the learner satisfaction and knowledge or skills retention between groups.

Therefore, this study aims to investigate if a new method of teaching and learning through a GBL is more effective than the conventional method in terms of students’ satisfaction and application of knowledge.

METHODS

Study Design

This study aimed to table the outcomes of two different pedagogies, and therefore the most suitable quasi-experimental design was selected (17).

Sample Size

The convenience sampling strategy was used. All clinical year students who enrolled or registered for the O&G posting were included in this study. The sample size calculation was based on the earlier trial (18). With a power of 0.8, 37 participants were needed in each arm for a suitably powered study. The study was conducted over two academic years (2019–2020), and 128 students participated in the study.

Preparation Before the Study

Eight web-based mobile-friendly games were created through Twine web-based game software developed by Interactive Fiction Technology Foundation (19). The conventional methodology focused on routine CBL on the same medical issues as in the GBL. For face validity, all learning materials were vetted by content experts. A player was given a mobile-friendly game site link where there are three different games with three different case scenarios; the participant has to take multiple pathways to reach the correct diagnosis. If the participant chooses the wrong pathway, the game is over for them, while those who managed to take the correct pathway progressed into the next steps to continue to level 2, level 3, and so on. The participants were also required to attend the debriefing session at the end of the gameplay.

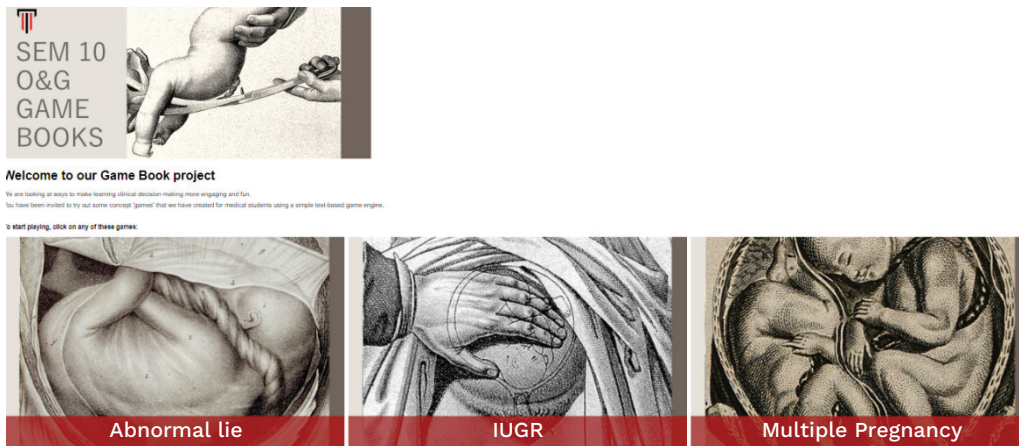


Figure 1: GBL cover page.

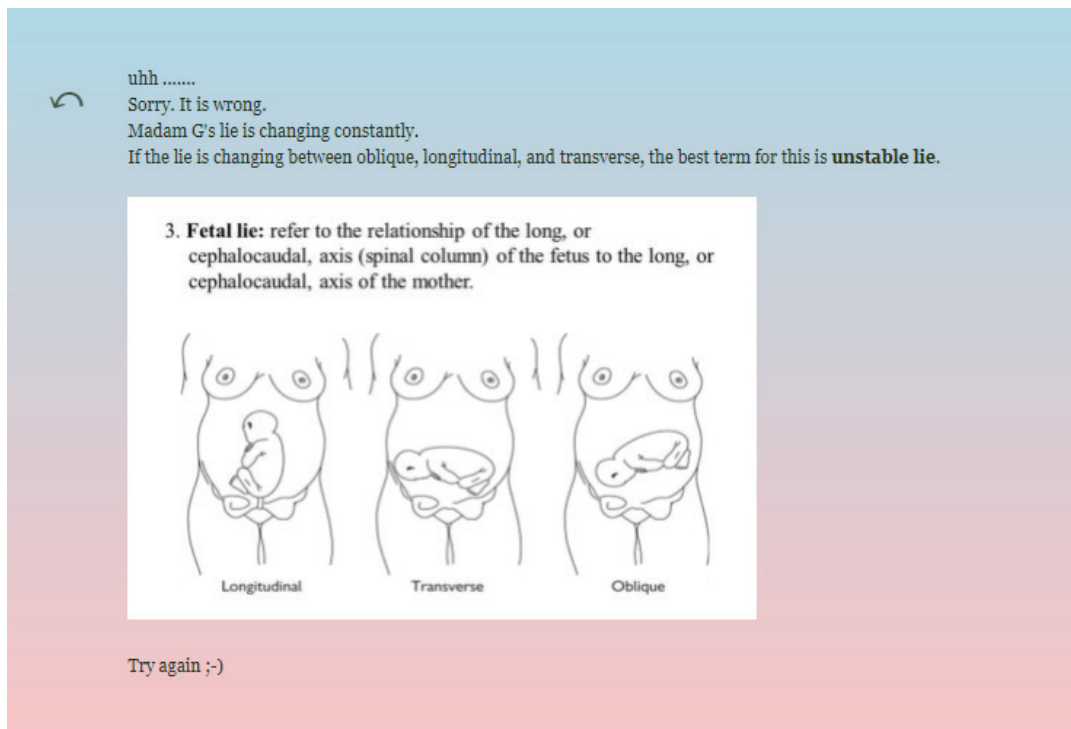


Figure 2: Example of GBL content.

Outcome Measurement

Single-best-answer multiple-choice question (MCQ) exams assessed the achievement of learning outcomes of the study seven days after either conventional CBL or GBL, while a 5-point Likert scale and feedback assessed the participants' perceptions at the end of the study.

For the postinterventional assessment, each set of questions consisted 24 vetted MCQs, which are validated by content expert for content validity. A pilot study was conducted to evaluate the internal consistency and reliability by using Cronbach's alpha calculation based on the Kuder-Richardson formula for dichotomised responses, i.e. correct/wrong (20). Cronbach's alpha of 0.6, 0.6, and 0.7 for Semesters 5, 8, and 10 show an acceptable level of internal consistency for each MCQ set. Test-retest reliability was evaluated using bivariate analysis of the total scores, obtaining Spearman's correlation coefficient of 0.92 ($p = 0.001$), 0.87 ($p = 0.005$), and 0.96 ($p < 0.001$) for Semesters 5, 8, and 10, respectively, showing highly correlated test and retest scores.

Survey of Students' Perception

A self-administered, online-based survey was developed to evaluate the students' perception of the learning modes at the end of the study. Reliability was assessed using Cronbach's alpha and interitem correlation, making the necessary refinements to the items until Cronbach's alpha value of 0.9 was achieved. The finalised five survey items, each with Likert scale responses ranging from 1 (strongly disagree) to 5 (strongly agree), are listed below. All responses were submitted anonymously.

The survey items and response are as follows:

- a. I enjoy learning O&G through GBL/CBL.
- b. I feel confident in managing the O&G patients by learning through the GBL/CBL.
- c. I find that learning through the GBL/CBL was an efficient use of my time.
- d. I am confident that I will be able to apply what I learned O&G through GBL/CBL to the workplace (to real patients).
- e. I find that learning through the GBL/CBL helped me engage well with the learning topics.

Baseline Academic Ability

Students' performance scores from prior assessments (baseline academic ability) were factored into the analysis of the MCQ results, where relevant. Chi-squared test and student's *t*-test were used to identify any significant difference in the prior exams' marks between the two groups.

Data Management and Analysis

All MCQ scores from both groups were evaluated as mean and standard deviation and/or median and interquartile range. For groups that showed no significant differences in their baseline academic ability, student's *t*-test was performed to evaluate between-group

comparisons of MCQ scores. Where there was a significant difference in baseline academic ability between the two groups, an analysis of covariance (ANCOVA) was performed to evaluate the effects of learning mode on MCQ scores while accounting for this confounder, after confirming that all assumptions were met. A *p*-value of < 0.05 was considered statistically significant.

The Likert responses of the five-item survey were presented as median and interquartile range and frequencies. The Mann-Whitney U test was performed to evaluate the differences in the median responses between GBL and CBL groups for each survey item. Correction for multiple comparisons was performed using the Bonferroni method, obtaining a *p*-value significance threshold of 0.05/20 = 0.0025. All statistical analyses were performed using SPSS version 26 (SPSS Inc., Chicago, Illinois, USA).

RESULTS

Table 1 shows that 128 medical students from Year 3 (Semester 5), Year 4 (Semester 8), and Year 5 (Semester 10) participated in the study.

Table 1: Number of students by semester, batch, and gender

Year of study	Number of participants		
	GBL	CBL	Total
Semester 5	24	24	48
Semester 8	21	20	41
Semester 10	20	19	39

Table 2: Gender distribution

Gender	Male	27	28	55
	Female	38	35	73

Postintervention MCQ Scores

Table 3 shows the postintervention MCQ scores for each semester. There were no statistically significant differences in the scores between GBL and CBL groups in all semesters. For Semester 10, this was true after considering their end of posting marks as a covariate.

Table 3: Postintervention MCQ scores for GBL and CBL groups by semester

Semester	GBL	CBL	<i>P</i> -value
Semester 5			
Mean, % (SD)	79.3 (7.3)	81.9 (12.5)	NS
Median, % (IQR)	79.2 (75–87.5)	83.3 (75.0–91.7)	
Semester 8			
Mean, % (SD)	73.1 (11.0)	71.3 (13.6)	NS
Median, % (IQR)	75.0 (65–80)	70.0 (60.0–85.0)	
Semester 10			
Mean, % (SD)	70.6 (11.8)	73.9 (14.6)	NS
Median, % (IQR)	68.8 (66.7–82.3)	75.0 (66.7–83.3)	

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Table 3: (Continued)

Semester	GBL	CBL	P-value
All semesters			
Mean, % (SD)	74.6 (10.6)	76.1 (14.1)	NS
Median, % (IQR)	75.0 (66.7–81.7)	79.2 (66.7–87.5)	

Note: NS = Not significant

Students' Perception of GBL and CBL

Of the 128 student participants, 127 valid survey responses were received. A single respondent was excluded as he/she had erroneously submitted.

Overall Survey Responses on Students' Perception of GBL and CBL

Table 4 summarises the median responses for each survey item and between-group comparisons for all 127 valid survey responses, and Table 5 summarises the response of frequencies.

Table 4: Summary of median responses for survey items 1 to 5 in Semester 5 students

Response	Group		P-value
	GBL	CBL	
Number of subjects, n	24	24	–
Median response for Survey Item 1 (IQR)			
I enjoy learning O&G through GBL/CBL.	5 (5–5)	4 (3.00–5.00)	< 0.001
Median response for Survey Item 2 (IQR)			
I feel confident in managing the O&G patients by learning through GBL/CBL.	5 (5–5)	4 (3.00–4.00)	< 0.001
Median response for Survey Item 3 (IQR)			
I find that learning through GBL/CBL was an efficient use of my time.	5 (5–5)	4 (3.25–4.75)	< 0.001
Median response for Survey Item 4 (IQR)			
I am confident that I will be able to apply what I learned O&G through GBL/CBL to the workplace (to real patients).	5 (5–5)	4 (3.25–5.00)	< 0.001
Median response for Survey Item 5 (IQR)			
I find that learning through GBL/CBL helped me engage well with the learning topics.	5 (5–5)	4 (4.00–4.75)	< 0.001

Table 5: Frequencies of responses for survey Q1–Q5 in Semesters 5, 8, and 10

Frequency of response		Strongly disagree	Disagree	Neutral	Agree	Strongly agree	Total	
Item 1	GBL	Frequency	0	0	1.0	8.0	55.0	64
		%	0	0	1.6	12.5	85.9	100
Q1	CBL	Frequency	0	2.0	10	29.0	22.0	63
		%	0	3.2	15.9	46.0	34.9	100

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Table 5: (Continued)

Frequency of response			Strongly disagree	Disagree	Neutral	Agree	Strongly agree	Total
Item 2 Q2	GBL	Frequency	1.0	1.0	5.0	15.0	42.0	64
		%	1.6	1.6	7.8	23.4	65.6	100
	CBL	Frequency	1.0	3.0	17.0	24.0	18.0	63
		%	1.6	4.8	27.0	38.1	28.6	100
Item 3 Q3	GBL	Frequency	0	0	2.0	13.0	49.0	64
		%	0	0	3.1	20.3	76.6	100
	CBL	Frequency	0	2	15.0	24.0	22.0	63
		%	0	3.2	23.8	38.1	34.9	100
Item 4 Q4	GBL	Frequency	0	1.0	4.0	18.0	41.0	64
		%	0	1.6	6.3	28.1	64.1	100
	CBL	Frequency	1.0	4.0	11.0	26.0	21.0	63
		%	1.6	6.3	17.5	41.3	33.3	100
Item 5 Q5	GBL	Frequency	0	0	3.0	8.0	53.0	64
		%	0	0	4.7	12.5	82.8	100
	CBL	Frequency	0	0	10.0	28.0	25.0	63
		%	0	0	15.9	44.4	39.7	100

Summary of Quantitative Analysis

Overall, students in the GBL group were significantly more likely to find learning more enjoyable, felt more confident about managing patients both theoretically and in the real world, perceived the learning mode as an efficient use of their time, and reported better engagement with the learning topics than those in the CBL group.

Analysis of Qualitative Comment

Generally, their comments were divided into two main themes: positive feeling towards GBL, while the other group felt more inclined towards traditional CBL. The positive comments for GBL were further divided into four subthemes: engaging, fun, improvement of understanding, and motivation.

GBL is engaging

One student commented, “Usually in normal CBL class, I find it hard to concentrate after one or two triggers because it is an online class but this game class allows me to participate and go at my own pace and I benefited more from it than usual class.”

Another student from Semester 5 supported, “Gamebook is more interactive. Engaging activities may be better for learning. Looking forward to try more gamebooks.”

GBL is fun

This was clearly mentioned several times in their comments. A student suggested, “I loved it, maybe if there are more effects, it may even be more fun.”

Some other students also shared the same view, “I suggest more gamebooks because it is fun and practical.”

“It is a good method of learning. I enjoyed it.”

“It’s a fun interaction!”

GBL improves understanding

A student voiced, “I like the game a lot. It helps us understand and educates us on which is the BEST management for the patient.”

Others supported, “I was able to think calmly and make decisions.”

“Go at my own pace and I benefited more from it than usual class.”

GBL is motivating

A student shared his/her experiences, “Overall, the gamebook is interesting, and it motivates me to study more.”

Other students experienced the same.

“It is an effective way of learning as it encourages self-study during preparation.”

“I did not feel bad when I answered questions wrongly; instead, I learned why I got them wrong.”

DISCUSSION

This study found that there is no difference in factual recall between GBL and CBL at seven days post-test. A similar study conducted in the Ontario College of Family Physicians in Toronto focused on physicians’ knowledge of stroke prevention and management. The result suggested that there was potentially better long-term knowledge retention in GBL (21). Since the duration of the test after the intervention is seven days, it is most likely that most of the factual knowledge overrides the conceptual knowledge in short-term memory. It could be possible that there is no significant difference in short-term memory between the two methods. This hypothesis is also supported by Chang et al. (22) who advocated that significant memories are transformed from short-term to long-term memory by repetition. In that sense, repeated stimulation is necessary to store long-term memory. Moreover, Chang et al. (22) noted that long-term memory storage is determined not only by frequency but also by the interval between the stimuli. Compared to this study, it can be postulated that students who were in GBL have a greater potential of recalling important O&G concepts than a group of students who might have learned the same material through conventional CBL. However, such a hypothesis must be investigated further, at least in light of GBL, before the results can be generalised.

One of the findings of this study is that students on GBL found that learning is more enjoyable and increased their confidence in navigating through relatively complex patient conditions. Therefore, it can be postulated that students on GBL had “virtually experienced” the real-

life scenarios of working in O&G setting, which in turn stimulated their critical thinking abilities. However, very little is known about how GBL facilitates this process. Therefore, further studies are recommended.

In 2008, a randomised controlled trial conducted in Germany found that cognitive learning outcomes were significantly and effectively higher in the game-based group than in the conventional script group (18). In contrast, the results of this study reported that there was no significant difference in cognitive outcomes between the two groups. The population size of their study was very similar to this study. Third-year medical students were recruited in their study, whereas third-, fourth-, and fifth-year medical students were enrolled in this study. In terms of intervention, their focus of the study subject matter was on urology and an adventure game was used, while this study used a concept game in O&G. For outcome measurements, both studies used MCQs to assess cognitive outcome and survey items for attitude assessment. The major differences between the two studies are the methodology and type of the game used as an intervention. Their study design was a randomised controlled trial (RCT), whereas a quasi-experimental design was used in this study. Traditionally, it is believed that RCT is a more powerful study design. This may explain why the outcomes of the studies provide different results.

The results clearly show in favour of GBL. It can be concluded that students enjoy learning more through GBL and feel more confident about their knowledge base after studying through the games and believe that it applies to the real-life work environment. Furthermore, most of the students reported that GBL was time-effective and engaging. Boeker et al. (18) reported similar results and suggested that students' attitudes towards GBL were significantly higher than the conventional CBL. In contrast, some authors have argued that excessive gaming could lead to negative psychosocial impacts (23). Due to these contrasting views, it can be considered that time management is vital to prevent unintended consequences of GBL. Therefore, teachers using educational games in teaching and learning should carefully balance to reap the benefits and avoid harm.

Next, similar results were found in Mann et al.'s study (24). In their pre- and post-test study, patients' histories were provided, and the players were requested to choose the investigation and appropriate management. Mann et al. (24) reported that the result of five-question attitude assessment survey was significantly positive towards GBL.

In this study, for Semester 5 students, the results were significantly higher in the GBL group than in the CBL group in the five-question attitude assessment survey. This finding is consistent with other literature where it finds younger students to be better suited for GBL as compared to older students because they find the activity to be more enjoyable (25). They also declared that the stress levels of medical students were highest among students facing examinations. It can be presumed that the stress factors might also play a role as to why junior medical students felt that GBL was more enjoyable.

Akl et al.'s (26) study reported that GBL was more enjoyable even though there was no significant effect on knowledge gained. Although such authors were not able to provide insights into the theoretical underpinnings of GBL or discuss its effectiveness on clinical teaching, what still stands is that the content of any GBL must be aligned with the module's learning outcome. It is also supported by Xu et al. (27) who mentioned that as a novel and promising teaching method, GBL has gradually become popular in the medical education curricula.

In this study, the content of GBL was carefully aligned with the module's learning outcomes. The extent to which the learning objectives of a healthcare programme can be achieved through GBL remains unclear. In addition, Akl et al. recommended high-quality research (26) to explore the impact of educational games on patient management and performance outcomes.

CONCLUSION

In conclusion, GBL shows comparable knowledge retention, student satisfaction, and motivation to learn as traditional CBL. Factors influencing its success include learner motivation, game design, user-friendliness, and alignment with learning outcomes. Future research should explore GBL's integration into varied educational settings and its long-term learning impact, alongside assessing its scalability and cost-effectiveness across diverse institutions.

Limitations and Strengths

Due to the nature of pedagogical studies, it is not possible to design a double-blind randomised controlled trial. Another limitation in the design involves the small size of the study population as this study was conducted in a private medical school. Limitations of time and resources also prevented this study from further investigating the impact of GBL on patient management. The long-term impact of GBL and academic achievement cannot be confidently concluded by this study.

Notwithstanding these limitations, this study demonstrates several strengths of its own. Since the study used a quantitative quasi-experimental methodology, the scope to generalise for expansion is one of its inherent strengths. The key strength of this study is that it addressed and minimised all potential sources of bias by establishing baseline academic abilities and eliminating hierarchical relationships.

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ETHICAL APPROVAL

An ethical approval from Taylor's University and University of Dundee's were obtained (HEC 2020/025 and SMED REC Number 20/37, respectively).

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